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The evolution of e-government toward smart governance and AI-based public policy support systems

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Abstract

This article analyzes the evolution of e-government toward smart government, focusing on the integration of Artificial Intelligence-Based Decision Support Systems (AI DSS) into public policy formulation and government service delivery. This article employs an explanatory, sequential mixed-methods approach that combines bibliometric analysis and AI-based quantitative modeling. This research employs qualitative methods, with bibliometric analysis to map trends and thematic clusters in global research on e-government, e-governance, and AI in the public sector. Furthermore, qualitative analysis was conducted using NVivo to explore conceptual patterns through visualization of items clustered by coding similarity, treemaps, and word clouds. This approach allows for the identification of dominant themes, conceptual linkages, and paradigm shifts in the literature. The results indicate that e-government employs a digital administration approach focused on public services and bureaucratic efficiency, while e-governance advances in policy, management, and public participation. However, the integration of AI into public policy decision-making processes remains limited and fragmented. AI has been recognized as a crucial technological capability, but it has not yet been institutionalized as a governance intelligence layer within the public policy cycle. This situation indicates that AI-based smart governance is still in its developmental stage and has not yet been fully realized. This research contributes by proposing a conceptual framework that positions AI-based decision support systems as a mediating mechanism between e-governance and smart governance. By integrating technological intelligence into governance processes and institutions, this research provides a more comprehensive understanding of how smart governance can be operationalized in public policy.

Keywords

Evolution, e-Government, Smart governance, AI, Public policy

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Introduction

Digital transformation in governance plays a crucial role in realizing Indonesia Emas 2045 [1] [2]. The government has made strengthening the Electronic-Based Government System (SPBE) a national priority. This system is outlined in Presidential Regulation Number 95 of 2018 concerning SPBE and the 2025-2045 National Long-Term Development Plan (RPJPN) [3]. In its implementation, e-Government at the central and regional levels still shows significant gaps, particularly in terms of digital infrastructure, human resource capabilities, data integration, and community involvement. The SPBE Index, published by the Ministry of Administrative and Bureaucratic Reform (PANRB), provides a general overview of the extent to which bureaucratic digitalization has advanced [4]. This index focuses on internal policies and regulations that do not fully reflect national readiness in creating adaptive, inclusive, and service-oriented governance [1]. Global indices such as the UN E-Government Development Index (EGDI), the Digital Government Index (OECD), and the GovTech Maturity Index (World Bank) have not yet fully reflected Indonesia's condition [5].

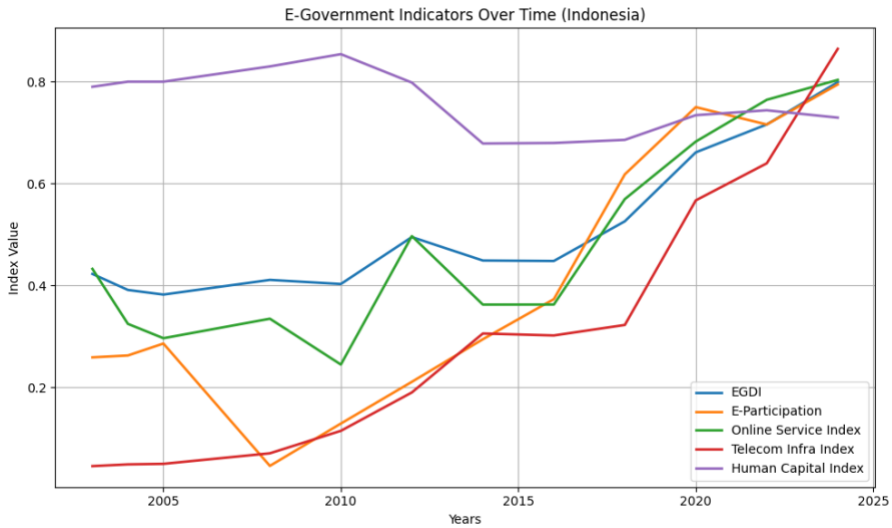

Figure 1. EGDI over time (Indonesia)

Figure 1 shows the development of e-government indicators from 2005 to 2025. The EGDI indicators show improvement and mutual reinforcement. The blue line (EDGI) shows steady progress from 0.38 to 0.799 in 2024. This indicates that digital governance is developing and progressing comprehensively. This development is influenced by the Telecommunication Infrastructure Index (red line), which initially ranged from 0.05 to 0.1 and then increased sharply to 0.87 in 2024. This indicates accelerated national-level digital infrastructure development. The Online Service Index (green line) also shows a sharp increase, from 0.25-0.49 in early 2005 to 0.79 in 2024. The quality and integrity of digital public services have improved significantly. The orange line (e-participant index) reached its lowest level in 2008 at 0.045, but has since risen to 0.79, indicating increasing public participation in digital governance. The purple line (human capital index) has been relatively high since 2005 and has stabilized at around 0.73-0.86. This indicates the need to strengthen human resource capacity to support digital transformation. Overall,

the combination of significant improvements in infrastructure, digital services, and public participation is driving EDGI in Indonesia. This also reinforces the positive trend of future government governance.

The E-Government Development Index (EGDI) in Indonesia shows a similar trend to that of other countries. Evaluated the EDGI by adding governance quality, inclusiveness, and policy coherence to the sustainable development program. Digitalization progress is rapid, but institutional readiness and policy integration between government agencies and levels are weak, creating gaps [6]. The gap between the central and regional governments in digital readiness will pose unique challenges for the government. A policy approach based on the National e-Government Readiness Index (NeGRI) can systematically map the digital divide. This allows the government to identify readiness in detail (infrastructure, human resources, data, and public participation) [7]. Furthermore, it can develop critical and systematic strategies based on empirical data. Collaboration at all levels of government is also essential [8].

Although the literature on e-government, e-governance, and smart governance is growing rapidly, several significant research gaps remain. First, the literature on the evolution of e-government remains limited to technological transformation, institutions, and mechanisms of policy formulation. Second, the use of artificial intelligence in the public sector focuses more on technical aspects and applications within specific sectors, without fully integrating governance and public policy formulation. Third, few studies integrate AI-based decision support (AI-DSS) into the concept of e-governance as a conceptual foundation for policymakers. This gap leads to a fragmented understanding of how smart technology actually shapes and transforms governance practices.

Based on this gap, this article presents a conceptual novelty: developing an analytical framework that maps the evolution of e-government toward smart governance by positioning AI-based Decision Support Systems as a key element in digital governance transformation. This approach goes beyond the narrative of administrative digitalization by emphasizing AI's role in enabling strategic, adaptive, and predictive decision-making in the public sector. Second, empirically and methodologically, this study combines bibliometric analysis and AI-based quantitative approaches to identify key patterns, trends, and clusters in global research, while also demonstrating how AI-DSS can be operationalized in a public policy context. Thus, this article contributes to the enrichment of the e-governance and smart governance literature by integrating smart technology and public governance perspectives.

Method

This research approach is qualitative with an interpretive foundation to deeply understand the evolution of e-government toward smart governance and the role of Artificial Intelligence-Based Decision Support Systems in the public policy formulation process [9]. Digital governance transformation is understood as a phenomenon that

involves not only technological change but also institutional change, inter-institutional relationships, and decision-making logic. Therefore, a qualitative approach was chosen because it can capture the meanings, dynamics, and conceptual constructions that develop within the concepts of e-government, e-governance, and smart governance [10]. This approach aligns with the theory of smart governance, which uses AI to integrate governance systems, organizational structures, and policy processes. The qualitative analysis in this article was carried out systematically and transparently using Nvivo [10]. In this paper, NVivo is used to manage and analyze qualitative data from reputable international journal articles in Scopus, classified into article categories on e-government, e-governance, and AI in public policy. This study identified key themes such as digital administration, networked governance, governance intelligence, evidence-based policy, and algorithmic governance, thus enabling a coherent and structured mapping of conceptual relationships [11].

Results

The data findings in this article are the result of data analysis using NVivo, which employs clustering by coding similarity, treemaps, and word clouds. These three data sets cannot be interpreted individually; they must be understood in an integrated manner to explain the evolution of e-government towards e-governance, smart governance, and AI-based public policy decision-making processes. These three data sets provide complementary empirical evidence in mapping the knowledge structure, themes, and direction of paradigm shifts.

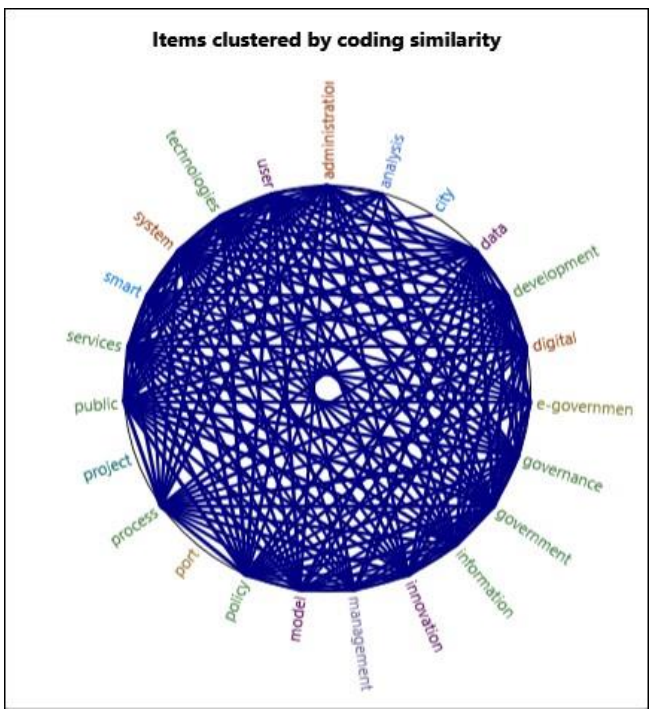

Figure 2. Data analysis in NVivo: items clustered by coding similarity

Figure 2 shows data analysis using NVivo's "Items Clustered by Coding Similarity" feature. The results show that the cluster analysis is based on coding similarities among

themes in the qualitative data. The circular network visualization demonstrates a strong relationship among key concepts, including e-government, governance, digital, information, administration, policy, management services, and technology. The density of connecting lines between concepts indicates that these themes often appear simultaneously and do not stand alone. This concept explains that e-government cannot be understood as a digital service alone but is integrated with public policy, public management, and the use of information and technology. This cluster pattern emphasizes the simultaneous interconnectedness of technology, institutions, and policy processes. Furthermore, the interconnectedness of administration, governance, and digital innovation demonstrates the conceptual shift from e-government to e-governance. It opens the door to integrating AI-based Decision Support Systems as intelligence that strengthens decision-making within a smart governance framework.

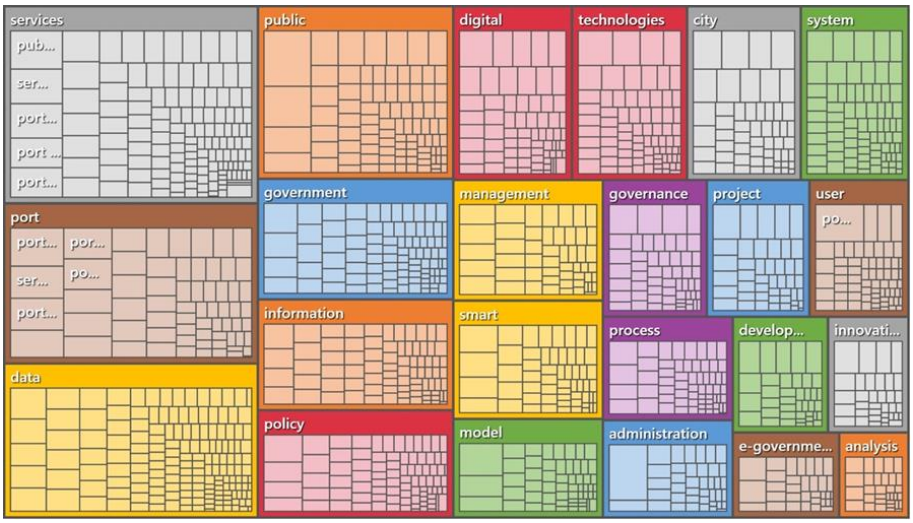

Figure 3. Treemap analysis by Nvivo

Figure 3 shows that the analysis treemap, a result of NVivo coding, illustrates the distribution and dominance of themes related to e-government, e-governance, and smart governance. Each box represents a primary theme, while the area indicates the theme's intensity and data frequency. The themes services, public, government, data, information, digital, technologies, and policy emerged most frequently, underscoring e-government's strong orientation toward the provision of public services, government administration, and data and information management. The themes, administrations, and projects demonstrate that a managerial and administrative approach is the primary foundation for e-government implementation, particularly during the digitalization phase.

The themes of governance, smart, model, analysis, and innovation demonstrate a conceptual shift toward more adaptive, knowledge-based smart governance. The relatively high number of data and analysis themes indicates an increase in data-driven decision-making, a key prerequisite for integrating AI-based Public Policy Support Systems. Overall, this visualization reinforces the research argument that the evolution of e-government toward smart governance is occurring gradually, with the need for AI

as an intelligence layer to transform data, information, and administrative processes into intelligent, evidence-based public policy support systems.

Figure 4. Word cloud analysis by NVivo

Figure 4 shows the frequency and dominance of two key concepts: e-government and e-governance. Terms such as government, public, services, information, digital, and administration appear most prominently. This confirms the initial paradigm, namely, that e-government is implemented as the digitization of administrative services. Technology is understood as an instrument to improve administrative efficiency, the quality of public services, and the management of government information. The dominance of terms indicates that the existing literature remains oriented towards service and administrative functions, thereby supporting the paper's argument that e-government is the initial foundation, not the ultimate goal, of digital governance transformation.

Furthermore, the emergence of the terms governance, policy, management, participation, integration, and systems indicates a conceptual shift toward e-governance. At this stage, technology is not only understood as a supporter of administrative processes but also as an enabler of policy coordination, public management, and engagement among policymakers. This word cloud analysis shows that e-governance theory emphasizes the relationship between policy and the public, indicating a paradigm shift from hierarchical to networked, participatory governance. Furthermore, findings on data, systems, analysis, models, technologies, and decisions provide empirical evidence for integrating AI-based decision processes into a smart governance framework.

Discussion

In this discussion, research results are elaborated on the evolution of the e-government concept towards e-governance and smart governance, supported by artificial intelligence as a foundation for policy formulation.

Conceptual integration in items clustered by coding similarity

The visualization of data items clustered by coding similarity demonstrates a strong interconnectedness between the concepts of e-government, governance, digital, information, policy, management, administration, and services. The interconnectedness of these concepts demonstrates the building of a digital governance ecosystem. This finding supports the emphasis that digital transformation in government results from simultaneous interactions among technology, institutions, actors, and policy processes [12]. Consistent with previous research, several studies have shown that technology integration in governance can improve efficiency, transparency, and the quality of public services [13], [14], [15], [16]. This concept views e-government as the beginning of a paradigm shift towards e-governance and smart governance, driven by improvements in ICT-based institutional governance [17]. A critical view in the literature review is that high conceptual interconnectedness can lead to conceptual overstretch, in which the boundaries between e-government and e-governance become blurred and analytical precision is lost. Blurred boundaries can reduce the analytical rigor needed to evaluate the effectiveness of a particular initiative. For example, while e-government initiatives may focus on improving the efficiency of service delivery, e-governance initiatives may aim to increase democratic participation and transparency [18]. In this context, the NVivo visual findings emphasize the need for a more explicit framework to explain the mechanisms of transformation.

Dominance of administrative and service themes in the treemap

Data analysis using the NVivo tree map feature shows a dominance of themes such as services, administration, public, government, data, and information. This indicates that the e-government literature remains oriented toward digital administration and public service delivery. This finding is consistent with classical e-government theory and with previous research assessing the success of digital transformation from the perspectives of technology adoption, service quality, and bureaucratic efficiency. The following is a synthesis based on previous studies of classical e-government theory and previous research that evaluates the success of digital transformation from the perspectives of technology adoption, service quality, and bureaucratic efficiency:

1. Technology adoption
    a. Cloud computing: The adoption of cloud computing in e-government services is crucial, especially post-Covid-19, increasing efficiency, scalability, and citizen engagement. Key factors influencing adoption include technological, organizational, and external pressures such as the public health crisis and evolving citizen expectations [19].
    b. New technologies: The integration of technologies such as AI, big data analytics, and blockchain is crucial for creating a robust digital ecosystem. These technologies improve public administration efficiency, service delivery, and transparency [20], [21].

   c. Digital infrastructure: Successful digital transformation relies heavily on digital infrastructure, data management, and cybersecurity frameworks [20], [22].
2. Service quality
   a. Customer satisfaction and service quality: Metrics such as customer satisfaction, service quality, accessibility, ease of use, perceived security, and trust are critical for evaluating digital services. Automated and real-time services tend to outperform traditional digital services in these areas [23].
   b. User experience: Despite progress, challenges such as low digital self-motivation, privacy concerns, and a preference for traditional methods hinder the adoption of e-government services. Addressing these through targeted awareness campaigns and digital literacy initiatives is crucial [24].
   c. Service delivery: The UAE's proactive digital strategy, which leverages AI and IoT, aims to improve public service delivery, efficiency, and transparency, and highlights the importance of continuous innovation and adaptive policy frameworks [25].
3. Bureaucratic efficiency
   a. Electronic bureaucracy: Digital transformation has not eliminated bureaucracy, but it has transformed it into an electronic bureaucracy, characterized by automated electronic processes that can still be complex and less user-friendly. This requires improvement to align with Weber's ideal bureaucratic principles [26].
   b. Operational efficiency: Strategic alignment with national goals, leadership commitment, and infrastructure readiness are important factors enabling technology adoption, while barriers include technical complexity, financial constraints, and organizational resistance to change [21].
   c. Policy and Regulation: Government policy plays a critical role in achieving sustainable e-government by addressing security threats and ensuring a trusted and reliable virtual infrastructure [27].

Table 1. Administrative focus of the research

Aspects	Important Point	References
Technology Adoption	Cloud computing, AI, big data, blockchain, digital infrastructure, cyber frameworks	[19], [20], [21], [22]
Service Quality	Customer satisfaction, service quality, accessibility, ease of use, perceived security, trust	[22], [23], [24]
Bureaucratic Efficiency	Electronic bureaucracy, operational efficiency, policies, and regulations	[21], [26], [27]

Table 1 is seen as realistic and pragmatic, especially for developing countries still struggling in the early stages of digitalization. Many studies have shown that without a strong digital administrative foundation, discourse on e-governance and smart governance tends to be normative and difficult to implement. However, critical literature highlights that the dominance of administrative themes risks hindering more substantive governance transformation. E-government that stops at digital services

risks becoming technocratic governance, in which technology reinforces the bureaucratic status quo without changing the logic of policy decision-making.

Discourse structure in the word cloud: From information to decision

The word cloud displays dominant terms such as government, public, services, information, digital, and administration, followed by governance, policy, management, and systems. This pattern confirms that the literature has shifted from a focus on administration to policy governance, yet still positions information as an objective rather than a primary input for intelligent decision-making. In e-governance theory, information and public participation are seen as prerequisites for policy legitimacy, but do not necessarily guarantee decision quality.

Previous research pro-digital governance argues that increasing information availability and transparency will automatically improve policy quality. However, a counter-view emphasizes that information overload can actually weaken decision-making capacity if not supported by adequate analytical systems. In this context, the limited appearance of terms such as AI, machine learning, or decision support in the word cloud reinforces the finding that AI-based decision processes have not yet become mainstream discourse.

This finding aligns with criticisms in the smart governance literature that many "smart" initiatives remain symbolic and technology-oriented, without any real transformation of the policy process. Therefore, this word cloud demonstrates a gap between the potential of smart technology and its conceptual implementation in public governance.

AI-based decision process as a mediator of governance evolution

The three visual data sets are integrated, resulting in a consistent pattern: e-government is strong in services and administration; e-governance is developing in policy and participation; and the use of AI in smart governance has shown significant potential, but its application remains limited and has not yet been integrated into the public policy formulation process. This strengthens the argument in this study that AI-based public policy decision processes should be positioned as a mediator, not simply an additional tool. In the theory of AI-based Decision Support Systems, AI transforms data and information into predictive, adaptive, and evidence-based policy recommendations.

The integration of Artificial Intelligence (AI) in public policy decision-making is increasingly viewed as a transformative approach that goes beyond simply serving as an additional tool. The role of AI as a mediator in this context involves transforming data and information into predictive, adaptive, and evidence-based policy recommendations, thereby improving decision-making [18]. AI as a mediator in public policymaking and its use to transform data into actionable insights prioritize process and transparency, encouraging adaptive policies based on empirical data [18], [28], [29].

Conclusion

This study examines the evolution of e-government toward smart governance by examining the role of Artificial Intelligence-Based Public Policy Support Systems within a digital governance framework. Based on qualitative analysis supported by bibliometric mapping and thematic exploration using NVivo, this study confirms that digital governance transformation is a non-linear process and is not solely determined by technology. The results show that e-government is still predominantly implemented as digital administration, oriented towards public service provision, bureaucratic efficiency, and information management. While this approach is important, it is insufficient to address the complexity of contemporary public policy issues. The development of e-governance has expanded the role of digital technology into policy coordination, public management, and public participation. However, data and information generated by digital systems are still often treated as administrative outputs rather than as strategic inputs for intelligent policy decision-making.

The main contribution of this study lies in affirming the position of AI-based decision processes as an evolutionary mediator between e-governance and smart governance. This research demonstrates that despite the availability of data, digital systems, and analytics, AI has not been systematically integrated into the cycle of public policy formulation, implementation, and evaluation. As a result, AI-based smart governance remains at a potential stage and has not yet been fully institutionalized as a governance paradigm. This research also provides a balanced perspective on the debate regarding the use of AI in government. Risks such as algorithmic bias, accountability, and democratic legitimacy are recognized as important issues, but they do not justify rejecting AI. Instead, the research findings emphasize that AI should be integrated into a sustainable, participatory, and accountable e-governance framework, functioning as a decision-support system rather than a replacement for human decision-makers.

Overall, this research concludes that realizing smart governance requires integrating three key elements: institutional and policy sustainability, multi-stakeholder participation, and the institutionalization of AI-based public policy support systems within the public policy cycle. Without such integration, e-government initiatives risk stalling at the level of administrative digitization. This research provides a conceptual and empirical foundation for further research and policy formulation, particularly for governments seeking to move toward intelligent, adaptive, and evidence-based public governance in the era of artificial intelligence.

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